unit; and accessory equipment for relaying, filtering, amplifying, switching, etc.

The technique for the automatic-vehicle checkout system is to (1) question the vehicle with a number of sensing elements (transducers) under both static and dynamic conditions and (2) use logic and computer circuitry to segregate specific mechanical malfunctions. As an example of the system's thoroughness, eventually, a single bearing will be capable of isolation as a potential trouble source. And, this information can be relayed to the mechanic.

CLASSIFYING TESTS

Formulated mainly on the basis of measurements required to adequately determine vehicle performance, required tests are classified as follows: power pack tests, main electrical system tests, and auxiliary engine-generator system tests. Suspension tests and metal fatigue measurements are also being considered and could be incorporated without changing the basic system.

The computer-controlled checkout equipment can perform extremely detailed mechanical malfunction segregation, since the computer uses an interrelation of a number of measurements to diagnose malfunctions. Thus the computer scientifically duplicates the "know-how" method employed by the most skilled mechanic.

This interrelation of measurements is preprogrammed into the computer as used in the unit under test. Thus, in effect, the combined experience and skills of the designer and of the best malfunction diagnostician are incorporated into the checkout system performance.

The entire checkout operation is performed with the vehicle's components in their normal operating position and condition. No removal or disassembly is necessary.

CHECKOUT PROCEDURE

Basic actual operation of the checkout procedure is as follows:

A vehicle is fitted with the transducers and is then subjected to a static and starting test. If it passes these tests and is capable of operation, it is then loaded on a computer-controlled dynamometer. During the placement of transducers, the console operator calls out the appropriate program from the tape storage unit. The program is automatically loaded onto the Libratrol-500's "memory" drum (4,096-word capacity).

Signals from the transducers are transmitted to the computer, via the commutator and converter, where they are analyzed with respect to the stored program. Responses are stored in "memory" and then dumped

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work orders after checkout is completed.

The results obtained through use of this system, correlated with records of failure and operational data on laboratory-controlled life tests, would provide data required to construct length of life tables for any particular vehicle or power unit. Coupled with truth tables (tables of combinations of components through which alternate paths of measurement will allow elimination of all but the faulty part), these data would, when stored in a computer or controlled system, indicate whether the vehicle under test is satisfactory for a certain elapsed time or that a certain part or parts are faulty and must be replaced. After the computed life-prediction time (for the most severe operational conditions) had elapsed, the vehicle would be returned for tests and a new prediction.

Thus, by being able to predict the life expectancy of a vehicle or component scientifically, the system might eventually approach the last word in preventive maintenance.

The value of such a system can readily be seen in terms of extremely detailed mechanical malfunction isolation, elimination of unnecessary rebuilds and repairs, more efficient utilization of maintenance time, and the ability to eventually make accurate life-expectancy predictions at the manufacturing level, resulting in a greater degree of dependability.

PAST HISTORY

Considerable advances have been made in the development of equipment to test mechanical components on an individual basis. These have included Magnafluxing and X-ray for metal fatigue, dynamometers for power output analysis, and highly sophisticated ignition analysis equipment, to name but a few.

But until the introduction of the process-control computer there had been no means of analyzing a mechanical system as an integrated whole.

For lack of acceptable substitutes, heavy reliance has been placed on "audible response," that is, the ear of an experienced mechanic. This is often accompanied by the effective but extremely inefficient practice of disassembly to locate a worn or broken part.

Essentially, the automatic-checkout system for motor vehicles bears close relationship to computerized process-control systems. Both systems require the collection of vast amounts of data reflecting variations in the process, analysis of the data, and some form of display. The main difference comes in the use made of display.

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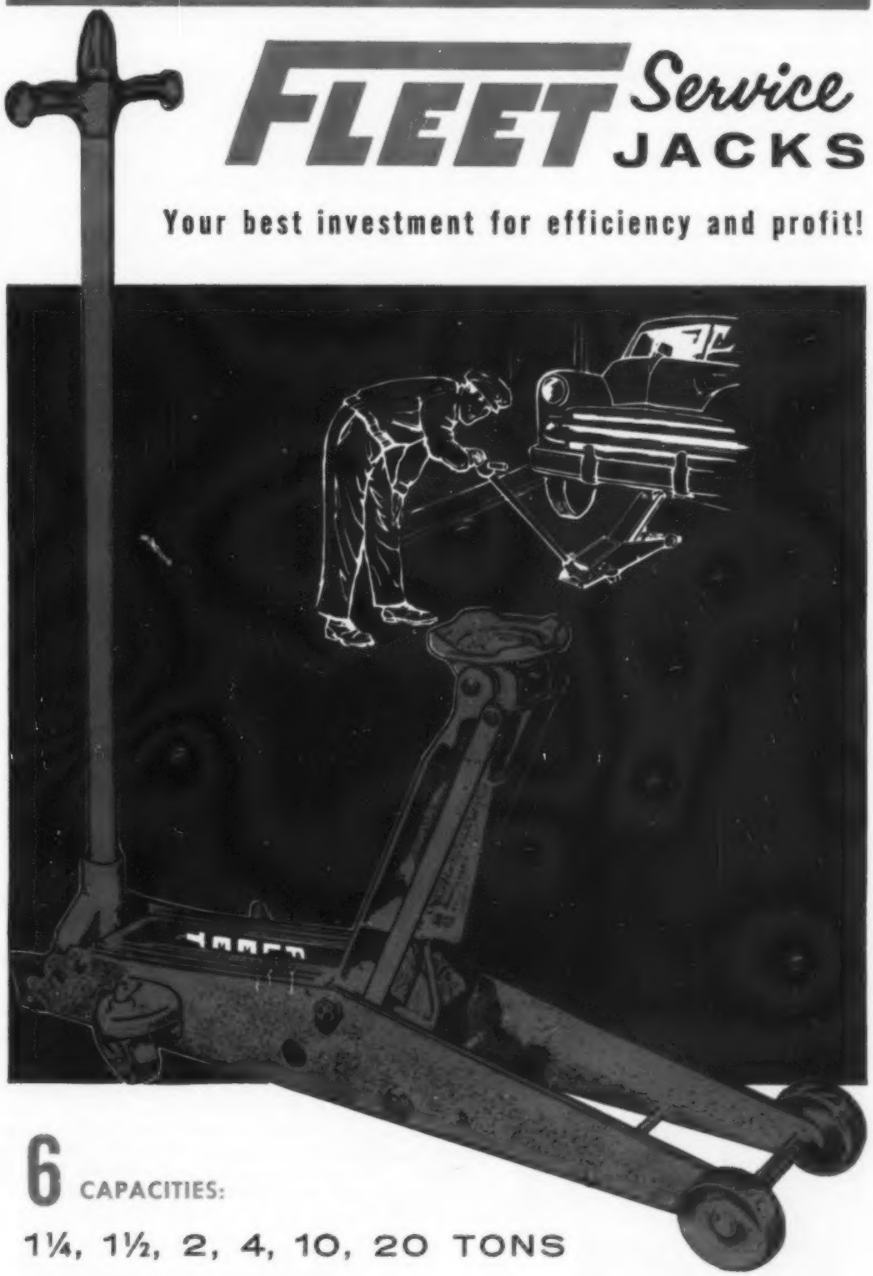

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